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(54) **Title:** LOW-TEMPERATURE OPERATIONAL AND STORABLE AMMONIUM DINITRAMIDE BASED LIQUID MONO-  
PROPELLANT BLENDS

(57) **Abstract:** Ammonium dinitramide based liquid monopropellants containing ADN, water, ammonia and, optionally, methanol,  
exhibiting improved low-temperature operational range are disclosed.



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# INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER  
INV. C06D5/08 C06B31/00  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
C06D C06B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data, COMPENDEX, CHEM ABS Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                          | Relevant to claim No. |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | NAGAMACHI M Y ET AL: "ADN - The new oxidizer around the corner for an environmentally friendly smokeless propellant", JOURNAL OF AEROSPACE TECHNOLOGY AND MANAGEMENT JULY-DECEMBER 2009 JOURNAL OF AEROSPACE TECHNOLOGY AND MANAGEMENT BRA, vol. 1, no. 2, July 2009 (2009-07), pages 153-160, XP002686701, | 1-5                   |
| Y         | page 159<br>-----<br>-/-                                                                                                                                                                                                                                                                                    | 1-9                   |

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                                                                               | Relevant to claim No. |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | ANFLO K ET AL: "Flight demonstration of new thruster and green propellant technology on the PRISMA satellite", ACTA ASTRONAUTICA NOVEMBER 2009/DECEMBER 2009 ELSEVIER LTD GBR, vol. 65, no. 9-10, November 2009 (2009-11), pages 1238-1249, XP002686702, DOI: 10.1016/J.ACTAASTRO.2009.03.056                                                                                    | 1                     |
| Y         | page 1244                                                                                                                                                                                                                                                                                                                                                                        | 1-9                   |
| X         | -----<br>Anders Larsson et al: "Green Propellants Based on Ammonium Dinitramide (ADN)", 14 February 2011 (2011-02-14), pages 139-156, XP002686703, DOI: 10.5772/13640 ISBN: 978-953-307-551-8 Retrieved from the Internet: URL:http://www.intechopen.com/books/advances-in-spacecraft-technologies/green-propellants-based-on-ammonium-dinitramide-adn-[retrieved on 2012-11-07] | 1                     |
| Y         | page 150                                                                                                                                                                                                                                                                                                                                                                         | 1-9                   |
| X         | -----<br>WO 02/096832 A1 (SVENSKA RYMDAKTIEBOLAGET [SE]; ANFLO KJELL [SE]; WINGBORG NIKLAS [SE]) 5 December 2002 (2002-12-05) cited in the application                                                                                                                                                                                                                           | 1                     |
| Y         | page 4, line 10 - line 27<br>page 3, line 17 - line 28<br>page 7, line 11 - page 8, line 10; claims                                                                                                                                                                                                                                                                              | 1-9                   |
| Y         | -----<br>WO 02/095207 A1 (SVENSKA RYMDAKTIEBOLAGET [SE]; GROENLAND TOR-ARNE [SE]; WESTERBERG BJO) 28 November 2002 (2002-11-28)<br>page 7, line 25 - line 32<br>page 33, line 22 - page 35, line 4                                                                                                                                                                               | 1-9                   |
| Y         | -----<br>WO 00/50363 A1 (SVENSKA RYMDAKTIEBOLAGET [SE]; ANFLO KJELL [SE]; WINGBORG NIKLAS [SE]) 31 August 2000 (2000-08-31)<br>page 4, line 8 - line 11<br>page 7, line 17 - line 27; example 2<br>page 11, line 10 - page 12, line 11; claims                                                                                                                                   | 1-9                   |
| A         | -----<br>WO 01/09063 A2 (ATLANTIC RES CORP [US]) 8 February 2001 (2001-02-08)<br>page 7, line 4 - line 10; claims                                                                                                                                                                                                                                                                | 1-9                   |
| A         | -----<br>WO 99/52839 A1 (TNO [NL]; DEN BERG RONALD PETER VAN [NL]; ELANDS PETRUS JOHANNES MARIA) 21 October 1999 (1999-10-21)<br>page 2, line 27 - line 33; claims                                                                                                                                                                                                               | 1-9                   |
|           | -----<br>-/--                                                                                                                                                                                                                                                                                                                                                                    |                       |

# INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | <p>DATABASE COMPENDEX [Online]<br/>ENGINEERING INFORMATION, INC., NEW YORK,<br/>NY, US;<br/>2004,<br/>KAPPENSTEIN C ET AL: "Non toxic ionic<br/>liquids as hydrazine substitutes.<br/>Comparison of physico-chemical properties<br/>and evaluation of ADN and HAN",<br/>XP002686704,<br/>Database accession no. E2005309232067<br/>abstract<br/>&amp; KAPPENSTEIN C ET AL: "Non toxic ionic<br/>liquids as hydrazine substitutes.<br/>Comparison of physico-chemical properties<br/>and evaluation of ADN and HAN",<br/>EUROPEAN SPACE AGENCY, (SPECIAL<br/>PUBLICATION) ESA SP - PROCEEDINGS OF SPACE<br/>PROPULSION 2004 - 2ND INTERNATIONAL<br/>CONFERENCE ON GREEN PROPELLANTS FOR SPACE<br/>PROPULSION 2004 EUROPEAN SPACE AGENCY NL,<br/>no. 557, 2004, pages 119-124,<br/>-----</p> | 1-9                   |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/SE2012/050589

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)  | Publication<br>date      |
|-------------------------------------------|---------------------|-----------------------------|--------------------------|
| WO 02096832                               | A1                  | 05-12-2002                  | AT 366233 T 15-07-2007   |
|                                           |                     | DE 60221003 T2 06-03-2008   |                          |
|                                           |                     | EP 1390323 A1 25-02-2004    |                          |
|                                           |                     | US 2004231765 A1 25-11-2004 |                          |
|                                           |                     | WO 02096832 A1 05-12-2002   |                          |
| WO 02095207                               | A1                  | 28-11-2002                  | AT 333045 T 15-08-2006   |
|                                           |                     | DE 60213085 T2 15-02-2007   |                          |
|                                           |                     | EP 1389271 A1 18-02-2004    |                          |
|                                           |                     | US 2005014641 A1 20-01-2005 |                          |
|                                           |                     | WO 02095207 A1 28-11-2002   |                          |
| WO 0050363                                | A1                  | 31-08-2000                  | AT 243177 T 15-07-2003   |
|                                           |                     | AU 3468000 A 14-09-2000     |                          |
|                                           |                     | BR 0008548 A 06-11-2001     |                          |
|                                           |                     | CN 1341086 A 20-03-2002     |                          |
|                                           |                     | DE 60003429 D1 24-07-2003   |                          |
|                                           |                     | DE 60003429 T2 06-05-2004   |                          |
|                                           |                     | EP 1192115 A1 03-04-2002    |                          |
|                                           |                     | IL 144743 A 20-06-2004      |                          |
|                                           |                     | JP 4536262 B2 01-09-2010    |                          |
|                                           |                     | JP 2002537218 A 05-11-2002  |                          |
|                                           |                     | NO 20014152 A 27-09-2001    |                          |
|                                           |                     | SE 513930 C2 27-11-2000     |                          |
|                                           |                     | SE 9900715 A 27-08-2000     |                          |
|                                           |                     | US 6254705 B1 03-07-2001    |                          |
|                                           |                     | WO 0050363 A1 31-08-2000    |                          |
| WO 0109063                                | A2                  | 08-02-2001                  | US 6984273 B1 10-01-2006 |
|                                           |                     | WO 0109063 A2 08-02-2001    |                          |
| WO 9952839                                | A1                  | 21-10-1999                  | AT 228492 T 15-12-2002   |
|                                           |                     | AU 767809 B2 27-11-2003     |                          |
|                                           |                     | AU 3346499 A 01-11-1999     |                          |
|                                           |                     | BR 9909684 A 19-12-2000     |                          |
|                                           |                     | CA 2328923 A1 21-10-1999    |                          |
|                                           |                     | CN 1301244 A 27-06-2001     |                          |
|                                           |                     | DE 69904158 D1 09-01-2003   |                          |
|                                           |                     | DE 69904158 T2 21-08-2003   |                          |
|                                           |                     | EP 0950648 A1 20-10-1999    |                          |
|                                           |                     | EP 1070031 A1 24-01-2001    |                          |
|                                           |                     | ES 2188150 T3 16-06-2003    |                          |
|                                           |                     | JP 4312383 B2 12-08-2009    |                          |
|                                           |                     | JP 2002511382 A 16-04-2002  |                          |
|                                           |                     | NO 20005188 A 25-10-2000    |                          |
|                                           |                     | RU 2226523 C2 10-04-2004    |                          |
|                                           |                     | US 6755990 B1 29-06-2004    |                          |
|                                           |                     | US 2004088910 A1 13-05-2004 |                          |
|                                           |                     | WO 9952839 A1 21-10-1999    |                          |
|                                           |                     | ZA 200006115 A 30-04-2001   |                          |